

REMARKS

In response to the Office Action, Applicant respectfully requests the Examiner to reconsider the above-captioned application in view of the foregoing amendments and the following comments.

Discussion of Claim Rejections Under 35 U.S.C. § 103

Claims 1, 2, 15, 29, and 35 are rejected under 35 U.S.C. § 103 as being unpatentable over JP 2002-334618. Applicant respectfully submits that the Claims 1, 2, 15, 29, and 35 are allowable over cited reference, for at least the reasons discussed below.

Discussion of Patentability of Independent Claims 1 and 8

Referring to “verified translation of Claims and paragraph 0013 to paragraph 0042 of JP 2002-334618” submitted on April 14, 2009,

The cited reference teaches such a process as claimed in Claim 1:

“A process for forming a conductive metal thin film using fine metal particle dispersion, which metal thin film is substitutionally used for a metal plating film, characterized in that:

the process comprising:

a step of forming a coating layer of said fine metal particle dispersion on the region where a conductive film to be substitutionally used for the metal plating film is to be formed; and

a step of subjecting the formed coating layer of the fine metal particle dispersion to heat-treatment at a temperature being no higher than 250°C to sinter the fine metal particles with each another contained therein;

wherein said fine metal particle dispersion used in the process is such a dispersion comprising an organic solvent that is used as a dispersion medium and a fine metal particle having an average particle size selected in the range of 1 to 100 nm, which is dispersed in the organic solvent,

the surface of the fine metal particle being dispersed therein is coated with one or more compounds having a group containing a nitrogen atom, an oxygen atom or a sulfur atom, which group is used as a group capable of forming a coordinative bond with a metal element contained in the fine metal particles, and

when the heat-treatment is carried out, the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element, is detached from the surface of the fine metal particle.” (Emphasis added)

Further, in paragraphs 0016 – 0018 of the reference explains the fine metal particle dispersion used for the process as follows:

“[0016]

In addition, the present invention provides an invention of a fine metal particle dispersion that is used for the process for formation of the conductive metal film as defined by the aforementioned features, which process is used substitutionally for plating. Namely, the fine metal particle dispersion according to the present invention is:

a fine metal particle dispersion being usable to form a conductive film, which film is substitutionally used for a metal plating film, characterized in that:

said fine metal particle dispersion comprises a fine metal particle having an average particle size selected in the range of 1 to 100 nm, which is dispersed in an organic solvent that is used as a dispersion medium thereof,

wherein

the surface of the fine metal particle being dispersed therein is coated with one or more compounds having a group containing a nitrogen atom, an oxygen atom or a sulfur atom, which group is used as a group capable of forming a coordinative bond with a metal element contained in the fine metal particles, and

the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element, is capable of being detached from the surface of the fine metal particle by heat-treatment at a temperature being no higher than 250°C.

[0017]

In the case of the fine metal particle dispersion according to the present invention,

it is preferred that the fine metal particle dispersion is characterized by:

a compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom at the temperature of carrying out the heat-treatment for the compound having the group containing the nitrogen, oxygen or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element to coat on the surface of the fine metal particle, is dissolved in the fine metal particle dispersion. In such a case, said compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom, which is contained in the fine metal particle dispersion, is preferably an organic acid anhydride or a derivative thereof or an organic acid.

[0018]

On the other hand, the fine metal particle dispersion according to the present invention, may include
such an embodiment of the fine metal particle dispersion,
wherein, in accordance with the material of the plating film to be substituted therewith, said fine metal particle contained in the fine metal particle dispersion is a fine particle made of a metal selected from the group consisting of gold, silver, copper, platinum, palladium, tungsten, nickel, tantalum, bismuth, lead, indium, tin, zinc, titanium and aluminum, or a fine particle made of an metal alloy of two or more metals selected from the aforementioned group of metals.”

Accordingly, the reference teaches clearly that when the heat-treatment at a temperature being no higher than 250°C is carried out, the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element, is detached from the surface of the fine metal particle.

In other words, the reference teaches clearly that when the heat-treatment at a temperature being no higher than 250°C is carried out, the fine metal particle contained in the fine metal particle dispersion, whose surface is coated with the compounds is converted into such a fine metal particle, from whose surface the compounds are totally detached out.

Of course, the reference teaches clearly that when the heat-treatment at a temperature being no higher than 250°C is carried out, the organic solvent that is used as a dispersion medium will be evaporated from the dispersion.

In the fine metal particle dispersion disclosed in the reference comprising the fine metal particle, the compound having the group containing the nitrogen atom, oxygen atom or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element, and the organic solvent, considerable part of the amount of the compound is used to cover the surface of the fine metal particle, whereas the remains of the amount of the compound is solved in the organic solvent at such a low temperature as room temperature (e.g. 25°C). The average density (C_{attached}) of the compound covering (being attached) on the surface of the fine metal particle is dependent on the concentration (C_{solved}) of the compound solved in the organic solvent at the low temperature as room temperature (e.g. 25°C).

In general, the solubility of the compound in the organic solvent increases when the temperature of the dispersion is elevated. Thus, when the temperature of the dispersion is elevated, the concentration (C_{solved}) of the compound solved in the organic solvent increases, whereas the average density (C_{attached}) of the compound covering (being attached) on the surface

of the fine metal particle decreases. As a result, when the temperature of the dispersion is elevated up to such a high temperature (for instance, 150°C), the compound is efficiently detached from the surface of the fine metal particle, and thereby, the average density (C_{attached}) of the compound covering (being attached) on the surface of the fine metal particle will decrease down to negligible level. On the other hand, when the temperature of the dispersion is elevated up to such a high temperature (for instance, 150°C), the solubility of the compound in the organic solvent increases up to sufficiently high level, so that all amount of the compound contained in the dispersion can be solved in the organic solvent.

Therefore, when the temperature of the dispersion is elevated up to such a high temperature (for instance, 150°C), in the fine metal particle dispersion, the fine metal particle whose surface is coated with the compound is converted into such a fine metal particle having no coating of the compound on its surface. The resulted fine metal particle having no coating of the compound on its surface may contact with each other so as to cause the low-temperature sintering, when the temperature of the dispersion is further elevated up to such higher temperature (for instance, 210°C). In such a case when all amount of the compound is solved in the organic solvent, the organic solvent as well as the compound solved therein may be evaporated away, when temperature of the dispersion is further elevated up to such higher temperature (for instance, 210°C).

As described above, the reference teaches such a process for forming a conductive metal thin film using fine metal particle dispersion, in which, when the heat-treatment at a temperature being no higher than 250°C is carried out, the fine metal particle whose surface is coated with the compound is successfully converted into such a fine metal particle having no coating of the compound on its surface by using the aforementioned mechanism. Accordingly, the reference fails to teach or suggest such fine metal particle dispersion, in which, when the heat-treatment at a temperature being no higher than 250°C is carried out, the fine metal particle whose surface is coated with the compound fails to be converted into such a fine metal particle having no coating of the compound on its surface, whereas only the evaporation of the organic solvent will be successfully attained.

In view of this fact, the cited reference by no means discloses any fine metal particles in the form of a dry powder, wherein the surface of the fine metal particles themselves is still covered with the compound, whereas the organic solvent is evaporated away.

At least, the reference teaches guideline for selection of the content of fine metal particle dispersion and condition of the heat treatment which is suitably used for the process for forming a conductive metal thin film using fine metal particle dispersion. However, the reference fails to provide any suggestion as to guideline for selection of the content of fine metal particle dispersion and condition of the heat treatment which is suitably used for such a process for preparing fine metal particles in the form of a dry powder, in place of conductive metal thin film made of fine metal particles, from fine metal particle dispersion.

Indeed, the reference provides good evidence proving that, when the heat-treatment at a temperature being no higher than 250°C is carried out to evaporate the organic solvent away from the dispersion, the fine metal particle contained in the fine metal particle dispersion, whose surface is coated with the compounds is successfully converted into such a fine metal particle having no coating of the compounds on its surface.

At least, the reference fails to provides any evidence suggesting that, when the heat-treatment at a temperature being no higher than 250°C is carried out to evaporate the organic solvent away from the dispersion, the fine metal particle contained in the fine metal particle dispersion, whose surface is coated with the compounds would fail to be converted into such a fine metal particle having no coating of the compounds on its surface.

In addition, the reference teaches such a preferable embodiment of the process for forming a conductive metal thin film using fine metal particle dispersion as claimed in Claim 2:

“The process according to claim 1,

wherein a compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom at the temperature of carrying out the heat-treatment for the compound having the group containing the nitrogen, oxygen or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element to coat on the surface of the fine metal particle, is dissolved in the fine metal particle dispersion, and

the detachment of the compounds having the group containing the nitrogen atom, oxygen atom or sulfur atom from the surface of the fine metal particle is accelerated by the reaction of the

compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom to the compound having the group containing the nitrogen, oxygen or sulfur atom.”

Further, in paragraph 0017 of the reference explains the fine metal particle dispersion suitably used for the preferable embodiment of process as follows:

“[0017]

In the case of the fine metal particle dispersion according to the present invention,

it is preferred that the fine metal particle dispersion is characterized by:

a compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom at the temperature of carrying out the heat-treatment for the compound having the group containing the nitrogen, oxygen or sulfur atom, which group is used as a group capable of forming a coordinative bond with the metal element to coat on the surface of the fine metal particle, is dissolved in the fine metal particle dispersion. In such a case, said compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom, which is contained in the fine metal particle dispersion, is preferably an organic acid anhydride or a derivative thereof or an organic acid.”

Further, the reference teaches the function and effect of the compound having reactivity to the group containing a nitrogen, oxygen or sulfur atom, which is contained in the fine metal particle dispersion, in paragraphs 0029 and 0030:

“[0029]

In addition, such a compound component which has reactivity to a group containing a nitrogen, oxygen or sulfur atom, when carrying out the heat-treatment for the aforementioned compound having the group containing the nitrogen, oxygen or sulfur atom as a group capable of coordinate-bonding to a metal element, which is coating the surfaces of the fine metal particles, for instance, an organic acid anhydride or a derivative thereof or an organic acid, may be added in the fine metal particle dispersion. The compound having reactivity to the group containing the nitrogen, oxygen or sulfur atom is used to remove, when heated, said coating layer covering the surfaces of the fine metal particles which are formed of the compound having the group containing the nitrogen, oxygen or sulfur atom as a group capable of coordinate-bonding to a metal element. That is, when heated, it reacts with the group containing the nitrogen, oxygen or sulfur atom in the coating compound which forms the coating layer around room temperature, and as a result of the reaction, it becomes difficult for the reacted group containing the nitrogen, oxygen or sulfur atom to form a coordinate bond to a metal atom on the surface of the fine metal particle, so that the coating layer is eventually removed. This removing capability is not exhibited around room temperature where the step of forming the coating film of the fine metal dispersion in the form of paste is

carried out, but is to be first exhibited in the step of subjecting the coating film to heat-treatment.

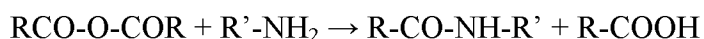
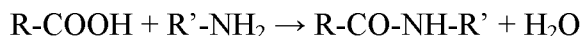
[0030]

Specifically, the acid anhydride or acid anhydride derivative added therein is used to form an amide, thioester or ester by reacting with the compound having the group containing the nitrogen, oxygen or sulfur atom such as an amine compound, thiol compound or diol compound under heating. Once formation of such amide, thioester or ester takes place, it becomes difficult for them to form the coordinate bond to the metal atom, so that the coating layer on the surface of the fine metal particle is removed as result. Therefore, at first, the very fine metal particle is dispersed uniformly from the first, and then as the organic solvent contained in a coating film is gradually evaporated out, the particle can take a closely packing state so as to fill; and as the heat treatment proceeds, the metal surfaces make direct contact with each other, and thus the fine metal particles undergo sintering even at a relatively low temperature. As a result, whole fine metal particles contained in the coating film are converted into a thin film of dense sintered product, the density of the thin film is comparable with that of the plating film.

Accordingly, the acid anhydride or acid anhydride derivative used for the reaction with the compound having the group containing the nitrogen, oxygen or sulfur atom at the step of removing the above coating layer is preferably added at least in an amount larger than the equivalent, on basis of the total amount of terminal amino groups, sulfanyl groups (-SH) or hydroxyl groups contained in such a compound as amine compound, thiol compound or diol compound mentioned above. In some cases, the acid anhydride or acid anhydride derivative may also react with a thin film of basic metal oxide when heated and have a function of producing a metal salt of a carboxylic acid thereof. Thus, in consideration of the reactivity, a slightly excessive amount is selected as appropriate.”

The reference teaches such use of carboxylic acid (R-COOH) or carboxylic acid anhydride (RCO-O-COR) as agent for removing the coating molecules such as alkyl amine from the surface of the fine metal particles, when heated up to a high temperature of no higher than 250°C (for instance, 150°C). The reference also teaches such use of carboxylic acid anhydride (RCO-O-COR) as agent for removing the thin film of metal oxide (MO) from the surface of the fine metal particles, when heated up to a high temperature of no higher than 250°C (for instance, 150°C).

Thus, the reference teaches the following reactions which are initiated by heating up to a high temperature of no higher than 250°C (for instance, 150°C)..



However, the reference fails to suggest that, when the heat-treatment at a temperature being no higher than 250°C is carried out, such metal salts of carboxylic acid $((\text{RCOO})_2\text{M})$ that are formed by the reaction of carboxylic acid anhydride (RCO-O-COR) with metal oxide (MO) would be used as a compound for coating on the surface of the fine metal particles, and the fine metal particles coated with the coating molecules such as alkyl amine would be converted to such fine metal particles coated with the carboxylic acid (R-COOH) or carboxylate $((\text{R-COO}^-)_2\text{M}^+)$, which can be dispersed in the organic solvent.

For instance, in Example 1 disclosed in the reference, such fine metal particle dispersion comprising 100 parts by mass of Ag fine particles with the average diameter of 8 nm, 15 parts by mass of dodecyl amine ($\text{Mw}=185.34$), as alkyl amine, 75 parts by mass of terpineol, as organic solvent, and 10 parts by mass of methyl-hexahydrophthalic anhydride (Me-HHPA ; $\text{Mw}=168.1$), as an acid hydride, is used in the process for forming a conductive metal thin film using fine metal particle dispersion.

At least, Example fails to provide any evidence suggesting that, when the heat-treatment at a temperature being no higher than 250°C is carried out, the fine metal particles coated with the coating molecules such as alkyl amine would be converted to such fine metal particles coated with any carboxylate, and thereby, such fine metal particles coated with any carboxylate (silver salt of methyl-hexahydrophthalic acid) in the form of a dry powder would be prepared, instead of the sintered product of Ag-fine particles, from the fine metal particle dispersion.

Further, the reference teaches the reaction that basic metal oxide of noble metal such as gold, silver, copper, platinum and palladium will be reacted with carboxylic acid (RCOOH) or carboxylic acid anhydride (RCO-O-COR) at a temperature being no higher than 250°C to produce noble metal salt of carboxylic acid. However, the reference fails to provide any suggestion as to such reaction that noble metal such as gold, silver, copper, platinum and palladium would be also reacted with carboxylic acid (RCOOH) or carboxylic acid anhydride (RCO-O-COR) at a temperature being no higher than 250°C to produce noble metal salt of carboxylic acid.

Indeed, it is well known that noble metal such as gold, silver, copper, platinum and palladium has no reactivity with any acid other than some strongly oxidizing acids. Thus, as carboxylic acid (RCOOH) or carboxylic acid anhydride (RCO-O-COR) is by no means a strongly oxidizing acid, noble metal such as gold, silver, copper, platinum and palladium is hardly reacted with

carboxylic acid (RCOOH) or carboxylic acid anhydride (RCO-O-COR) at a temperature being no higher than 250°C.

In contrast, as basic metal oxide of noble metal such as gold, silver, copper, platinum and palladium functions as basic material, the basic metal oxide will be converted to noble metal salt of carboxylic acid by acid-base reaction using carboxylic acid (RCOOH) or carboxylic acid anhydride (RCO-O-COR) at a temperature being no higher than 250°C.

Furthermore, it is well known that silver salts of carboxylic acid (RCOOAg) such as CH₃COOAg will be thermally decomposed at a temperature being no higher than 250°C (100°C for CH₃COOAg). Thus, the reference fails to provide no good reason to believe that such Ag fine particles coated with any Ag carboxylate (RCOOAg) in the form of a dry powder would be prepared from such Ag fine metal dispersion by using heat-treatment at a temperature being no higher than 250°C.

Even if the fine metal particle dispersion (starting material) is disclosed in the reference, there is no good reason to conclude that such a specific process for preparation of fine metal particles in the form of a dry powder from the fine metal particle dispersion according to the present invention would be *prima facie* obvious. In the case if such a specific process for preparation of the product is not obvious, such a novel product should be concluded to have an inventiveness.

The reference also fails to provide any suggestion as to the specific choice of the thickness of the covering layer formed with the adjusted covering amount such that “a thickness of the covering layer formed with the adjusted covering amount is at least 0.5 nm or thicker, and selected in the range of 2/10 to 8/10 of the average particle size of the fine metal particles”.

In such a case if the thickness of the covering layer for the fine metal particle in the form of a dry powder is optimized by experimental trial, the fine metal particles in the form of a dry powder having variety of the thickness of the covering layer should be compared with each other. Thus, the fine metal particles in the form of a dry powder having variety of the thickness of the covering layer should be prepared for such comparison.

However, the reference fails to teach or suggest any suitable process for preparation of the fine metal particles in the form of a dry powder having variety of the thickness of the covering layer. Therefore, a person skilled in the art can never routinely carry out such comparison among the fine metal particles in the form of a dry powder having variety of the thickness of the covering

layer in order to experimentally discover an optimum value of result-effective variable, based on the disclosure of the reference.

In paragraph 0034 and 0035 of the reference teaches the following criteria for selection of solvent contained in the fine metal particle dispersion:

“[0034]

As for the organic solvent used for these two purposes, different organic solvents may be used, but it is preferred that the same organic solvent is used. The organic solvent is not limited to a particular type as long as it is applicable for said two types of uses. It is preferable to select a nonpolar solvent or low polar solvent, rather than a high polar solvent in which the compound forming the coating layer on the surfaces of the fine metal particles, for example, such as an alkylamine, is so highly soluble that the coating layer on the surfaces of the fine metal particles may vanish away.

[0035]

In the process for formation of a conductive metal film that is substitutionally used for plating, according to the present invention, in addition, it is preferred that the organic solvent is capable of being relatively quickly evaporated and has thermal stability to such an extent that it does not undergo thermal decomposition even at a high temperature where a heat treatment for sintering is carried out after the step of coating. Further, in the case where a fine line is formed, as at the step of coating, the fine metal particle dispersion is applied by screen printing to form a coating film having a desired film thickness, the viscosity thereof must be kept within a desired liquid viscosity. Thus, in consideration of its ease of handling at such a step, a nonpolar solvent or low polar solvent with a relatively high boiling point which hardly evaporates around room temperature, for example, such as terpeneol, a mineral spirit, xylene, toluene, ethylbenzene and mesitylene, is preferably employed, or hexane, heptane, octane, decane, dodecane, cyclohexane or cyclooctane may be also used therefor.”

The reference clearly suggests that a nonpolar solvent or low polar solvent with a relatively high boiling point is fit to the criteria for selection of solvent, whereas a high polar solvent with a low boiling point is by no means fit to the criteria for selection of solvent.

Further, the reference clearly suggests that the solvent is also used as a reaction solvent for the reaction of the compound having reactivity with the compounds having the group containing the nitrogen, oxygen or sulfur atom in the step of heat treatment at the temperature being no higher than 250°C.

In view of these facts, the reference fails to suggest that alcohol solvents having a low boiling point of 80 °C or lower, ketone solvents having a low boiling point of 80 °C or lower and

acetonitrile (b.p. 82 °C) would be suitably used as a solvent to be contained in fine metal particle dispersion of the reference.

Accordingly, Applicant respectfully submits that the Examiner's assertion "JP 2002-334618 discloses the same utility for any polar solvents having a boiling point of greater than the room temperature and lower than the sintering temperature" is not accurate.

Furthermore, as the Examiner acknowledged, the reference does not specify the thickness of the covering layer as claimed in the Claims 1 and 15. In rejecting the claims, the Examiner took the position that the thickness is a result effective variable, because it would directly affected the final property of the particles as disclosed by the paragraph [0023] and [0024] of the reference. The Examiner further asserted that it would have been obvious to one skilled in the art to have optimized the thickness of the covering layer on the particle of JP '618 in order to achieve the desired properties of the particles. However, the paragraphs merely recites that the metal surface of the fine metal particles is to be densely covered and does not state anything about the optimization of the thickness of the covering layer on the fine metal particles, which are kept in the form of a dry powder.

A particular parameter must **first be recognized as a result effective variable**, ie., a variable which achieves a recognized result, before the determination of the optimum or workable range of said variable might be characterized as routine experimentation. *In re Antonie*, 559 F.2d 618, 195 USPQ 6 (CCPA 1977). In view of these facts, it appears that this instant feature was not recognized as a result effective variable and its criticality at the time of the claimed invention. Accordingly, one having ordinary skill in the art would have no way to come up the claimed limitation from the disclosures of the reference. Thus, no *prima facie* case of obviousness has been established with respect to Claims 1 and 15

Discussion of Patentability of Dependent Claims

The rest of the rejected claims depend from base Claim 1 or 15, and further define additional technical features of the present invention. In view of the patentability of their base claims, and in further view of the additional technical features, Applicants respectfully submit that the dependent claims are patentable over the prior art.

CONCLUSION

In the light of the applicant's amendments to the claims and the foregoing Remarks, it is respectfully submitted that the present application is in condition for allowance. Should the Examiner have any remaining concerns which might prevent the prompt allowance of the application, the Examiner is respectfully invited to contact the undersigned at the telephone number appearing below.

No Disclaimers or Disavowals

Although the present communication may include alterations to the application or claims, or characterizations of claim scope or referenced art, Applicant is not conceding in this application that previously pending claims are not patentable over the cited references. Rather, any alterations or characterizations are being made to facilitate expeditious prosecution of this application. Applicant reserves the right to pursue at a later date any previously pending or other broader or narrower claims that capture any subject matter supported by the present disclosure, including subject matter found to be specifically disclaimed herein or by any prior prosecution. Accordingly, reviewers of this or any parent, child or related prosecution history shall not reasonably infer that Applicant has made any disclaimers or disavowals of any subject matter supported by the present application.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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